The New International Standard Equation of State for Difluoromethane (R-32)

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Difluoromethane (R-32) is an ozone-friendly refrigerant which is a major component of various refrigerant blends used to replace R-22 and R-502 in low temperature refrigeration, air-conditioning and heat pump applications. Equations of state for these mixtures must rely on accurate models of their pure components, therefore, an accurate equation of state for pure HFC-32 is essential in order to formulate accurate mixture models.

The fundamental equation of state presented here is given in terms of the Helmholtz free energy from which all thermodynamic properties can be calculated. Its ideal part is based on new heat capacities calculated from statistical thermodynamics taking into account first order anharmonicity corrections. These new values differ by up to 3% from values obtained from calculations using the simple rigid-rotor harmonic oscillator approach. Agreement between the new heat capacities and values derived from measured speed of sound is within $\pm 0.1\%$.

The residual part of the Helmholtz free energy consists of 19 terms and represents thermodynamic properties between the triple-point (136.34 K) and 435 K at pressures up to 70 MPa. Typical uncertainties are $\pm 0.1\%$ in density, $\pm 0.8\%$ in heat capacity or $\pm 0.02\%$ in vapor pressure. Extrapolation above 435 K shows reasonable behavior for derived properties such as c_p , c_v or speed of sound. This equation has been adopted as an international standard formulation by IEA Annex 18 for the thermodynamic properties of R-32.